

Short communication

Nest site selection by fire ant queens

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Summary

We examined nest site selection by foundresses of the polygyne form of *Solenopsis invicta*. In the laboratory, foundresses were allowed to nest in control soil vs. soil inoculated with refuse from a colony of *Pheidole dentata*, a natural enemy. In a second experiment foundresses chose between control and *S. invicta* soil. More foundresses (100%) avoided the soil of a natural enemy than the soil of a conspecific colony (79%) that may accept them into the nest. Foundresses from this polygyne ant appear to avoid other colonies in general, but avoid heterospecific colonies more.

A chief cause of foundress mortality is predation by workers from nearby colonies (Pontin, 1960). At first consideration then, it might be adaptive if foundresses used cues to avoid nesting near mature ant colonies. However, foundresses from some multiple-queen species may be able to join an established colony (Hölldobler and Wilson, 1977; Keller, 1991). Even this is risky, since workers from conspecific nests may execute an approaching foundress on the spot.

In central Texas, the imported fire ant has flourished (Porter and Savignano, 1990) and the multiple-queen (polygyne) form (with up to 500 queens per nest, Vargo, unpub. data) predominates. Foundresses of *S. invicta* attempt both to found alone and join mature colonies (Porter, 1991; pers. obs.) dying in large numbers in the process (Whitcomb et al., 1973). Native ants, like *Pheidole dentata*, quickly pin down *S. invicta* alates while large-headed *P. dentata* soldiers clip the foundresses in two (unpub. data; see also Wilson, 1976; Feener, 1986). Here we show that foundresses of *S. invicta* strongly avoid nesting in soil with refuse from *P. dentata*, and less strongly avoid nesting in soil inoculated with refuse from *S. invicta*.

We set up two trials. The first gave *S. invicta* foundresses a choice between soils mixed with a bit of refuse from *P. dentata* and a control soil, the second between *S. invicta*-inoculated soil and a control soil. We used potting soil (Bacto, Michigan Peat Co.) for the control. For the treated soil, we used refuse piles (consisting of fine organic matter, dead

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ant bodies, other dead insects) from the nests of 2 *P. dentata* and 2 *S. invicta* laboratory colonies, mixed with potting soil in a 1:5 ratio by volume (ca. 1:15 by weight). Ants recognize nest material (Hangartner et al., 1970). Because nest refuse is typically deposited some distance from the nest entrance and washed even farther by rain, we thought refuse should be a good cue to nest proximity in the field. Control and treated soils were placed in two test tubes (10×1.2 cm) in a square plastic dish (9.3×9.3×1.5 cm). Each test tube contained ca. 2.5 ml of tap water sealed by a small cotton plug. About 2 ml of the soils were gently tamped into the test tube, leaving 4 cm of glass entrance.

On the afternoon of May 27, 1993 a large flight of polygene *S. invicta* emerged at the Brackenridge Field Laboratory in Austin, Texas. We aspirated wingless queens found running along the ground. The foundresses were randomly assigned to the dishes, the dishes were capped loosely with their clear lids, and foundresses were observed for 10 s to make sure they were active. After 24 hours, all foundresses from *Pheidole* and *Solenopsis* choice trials had excavated nests in the soil and/or laid eggs, suggesting that the foundresses treated the test tubes as nest sites.

Foundresses strongly preferred control soils in both trials. In the *Pheidole* trial, all the foundresses (24 of 24 versus the 12 expected, $P < 0.0001$, Fisher's Exact Test) chose the control soil. In the *Solenopsis* experiment, 79% of the foundresses (19, $P < 0.0001$, Fisher's Exact Test) chose the control soil. Foundresses avoided *Pheidole* soil more strongly than *Solenopsis* soil (100% vs. 79%, $P < 0.05$, Fisher's Exact Test). Put another way, foundresses were more likely to nest near conspecifics than heterospecifics.

Next, we weighed the foundresses. All were within the range of body weights characterizing polygyne foundresses ($\bar{X} \pm \text{SD} = 11.1 \pm 0.2$ mg, range = 8.4–14.4 mg; Porter et al., 1988; Keller and Ross, 1993), and no weight differences were found between treatments or nest choice. We killed the foundresses in alcohol, then checked them for sperm in the spermatheca, indicating a successful mating. As is common among functional queens in polygyne colonies of this species (Vargo and Fletcher, 1989), a third of the ants had no sperm (14 of 47, 29.8%, one ant was lost). However, all the foundresses choosing to nest in *S. invicta* soil were inseminated (5 of 5), versus 68% of the foundresses choosing the control soil ($P = 0.28$, Fisher's Exact Test). Although neither weight nor insemination status statistically influenced the nest site choice of the foundresses, the sample sizes may have been too small to detect any possible effects of these factors.

Ant colonies are often hyper-dispersed due to selective predation by mature ant colonies (Levings and Traniello, 1981; Rytí and Case, 1988). Here we show that foundresses may avoid other nests. Many cues are possible, including nest refuse (this study) and perhaps trail pheromones (Kawecki, 1992). Similar cues may be used to find and form nest associations (e.g., Bartz and Hölldobler, 1982; Tschinkel and Howard, 1983; Rissing and Pollack, 1986).

Foundresses may further respond differently to cues from different species. In this study foundresses of a polygyne ant were more likely to nest near a conspecific. In nature, polygyne *S. invicta* foundresses may stand a small probability of being adopted into a *S. invicta* nest (Glancey and Lofgren, 1988; Porter, 1991), whereas nesting near a heterospecific predator/competitor would likely doom the foundress. This rule may be reversed for monogyne species or populations that preferentially kill con- vs. heterospecific foundresses (Pontin, 1960). Further studies comparing specific vs. heterospecific avoidance from species and forms with different life histories should help shed light on the rules used by foundresses in selecting nest sites.

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References

- Bartz, S. H. and B. Hölldobler, 1982. Colony founding in *Myrmecocystus mimicus* Wheeler (Hymenoptera: Formicidae) and the evolution of foundress associations. *Behav. Ecol. Sociobiol.* 10: 137–147.
- Feener, 1986. Alarm-recruitment behavior in *Pheidole militica* (Hymenoptera: Formicidae). *Ecol. Ent.* 11: 67–74.
- Glancey, B. M. and C. S. Lofgren, 1988. Adoption of newly-mated queens: a mechanism for proliferation and perpetuation of polygynous red imported fire ants *Solenopsis invicta* Buren. *Fla. Entomol.* 71: 581–587.
- Hangartner, W., J. M. Reichson and E. O. Wilson, 1970. Orientation to nest material by the ant *Pogonomyrmex badius* (Latreille). *Anim. Behav.* 18: 331–334.
- Hölldobler, B. and E. O. Wilson, 1977. The number of queens: an important trait in ant evolution. *Naturwissenschaften* 64: 8–15.
- Kawecki, T. J., 1992. Young queens of the harvesting ant *Messor semirufus* avoid founding in places visited by conspecific workers. *Ins. Soc.* 39: 113–115.
- Keller, L., 1991. Queen number, mode of colony founding, and queen reproductive success in ants (Hymenoptera, Formicidae). *Ethol. Ecol. Evol.* 3: 307–316.
- Keller, L. and K. G. Ross, 1993. Phenotypic plasticity and “cultural transmission” of alternate social organizations in the fire ant *Solenopsis invicta*. *Behav. Ecol. Sociobiol.* 33: 121–129.
- Levings, S. C. and J. F. A. Traniello, 1981. Territoriality, nest dispersion, and community structure in ants. *Psyche* 88: 265–319.
- Pontin, A. J., 1960. Field experiments on colony foundation by *Lasius niger* and *L. flavus* (F.) (Hym., Formicidae). *Ins. Soc.* 7: 227–230.
- Porter, S. D., 1991. Origins of new queens in polygene red imported fire ant colonies. *J. Entomol. Sci.* 26: 474–478.
- Porter, S. D. and D. A. Savignano, 1990. Invasion of polygyne fire ants decimates native ants and disrupts arthropod community. *Ecology* 71: 2095–2106.
- Porter, S. F., B. Van Eimeren and L. E. Gilbert, 1988. Invasion of red imported fire ants (Hymenoptera: Formicidae) microgeography of competitive replacement. *Ann. Entom. Soc. Am.* 81: 913–918.
- Rissing, S. W. and G. B. Pollock, 1986. Social interaction among pleometrotic queens of *Veromessor pergandei* (Hymenoptera: Formicidae) during colony foundation. *Anim. Behav.* 34: 226–233.
- Ryti, R. T. and T. J. Case, 1988. Field experiments on desert ants: testing for competition between colonies. *Ecology* 69: 1993–2003.
- Tschinkel, W. R. and D. F. Howard, 1983. Colony founding by pleometrosis in the fire ant *Solenopsis invicta*. *Behav. Ecol. Sociobiol.* 12: 103–113.
- Vargo, E. L. and D. J. C. Fletcher, 1989. On the relationship between queen number and fecundity in polygyne colonies of the fire ant *Solenopsis invicta*. *Physiol. Entomol.* 14: 223–232.
- Whitcomb, W. H., A. Bhatkar and J. C. Nickerson, 1973. Predators of *Solenopsis invicta* queens prior to successful colony establishment. *Environ. Entomol.* 2: 1001–1003.
- Wilson, E. O., 1976. The organization of colony defense in the ant *Pheidole dentata* Mayr (Hymenoptera: Formicidae). *Behav. Ecol. Sociobiol.* 1: 63–81.

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